

GUJARAT UNIVERSITY
Department of Botany, Bioinformatics & Climate Change Impacts Management
REVISED SYLLABUS for M. Sc. Botany
Effective from June 2022

1. There will be Four Papers (Three Hour Duration) and Two Practicals (Six hour Duration) of One Hundred (70 External + 30 Internal) Marks each at Semester Examination.
2. The Botanical Excursion is highly essential for studying vegetation in its natural state. There shall be at least one Botanical excursion in and outside Gujarat State for each year. Tour report and submission of specimens will be given due weightage.
3. Candidate shall be required to submit at the time of practical examination at the end of each semester.
 - The laboratory Journal and diary of field work (Tour report) duly signed by the teachers concerned from time to time.
 - A set of Slides, Preparations or Materials illustrating the subject - matter as per syllabus for each semester.

Distribution of Marks

INTERNAL MARKS

PRACTICAL:

M.Sc.	Seminar	Experiment	Total	Assignment/ Review article	Experiment	Total	Strategic Planning/ Project
Sem I		BOT 405			BOT 406		
Marks	10	40	50	10	40	50	---
Sem II		BOT 411			BOT 412		
Marks	10	40	50	10	40	50	---
Sem III		BOT 505			BOT 506		
Marks	10	40	50	10	40	50	---
Sem IV	30			30			120
* Note: Practical internal 50 marks to be converted in to 30 marks: Exam time 6 hrs.							

Theory:

Semester	Per Paper / Marks	Papers	Total
I	50	4	200
II	50	4	200
III	50	4	200
IV	--	--	--

* Note: Theory internal 50 marks to be converted in to 30 marks: Exam time 1.5 hrs
Time for External 3 hrs.

Semester	Theory			Practical			Grand
	Internal	External	Total	Internal	External	Total	Total
I	30 X 4 = 120	70 X 4 = 280	400	30 X 2 = 60	70 X 2 = 140	200	600
II	30 X 4 = 120	70 X 4 = 280	400	30 X 2 = 60	70 X 2 = 140	200	600
III	30 X 4 = 120	70 X 4 = 280	400	30 X 2 = 60	70 X 2 = 140	200	600
IV	Seminar /Assignment 30 X 2=60	Seminar /Assignment 70 X 2=140	200	Project- 120	Project- 280	400	600
							2400

Seminar:

- Topics will be allotted in the beginning of the each semester.
- On due date student has to present the seminar on allotted topic and submit compiled literature.
- Presentation would be evaluated.

Assignment / Submission:

- Student must Prepare / Collect specific literature / Herbarium / Material pertaining to the topics in Botany.
- Student may take up survey work in guidance of the department.
- Assignment / submission would be evaluated.

Project:

- Based on the papers and topics studied, student must select a line of research; prepare a project proposal (comprising introduction, literature survey, problem, target, methodology, probable outcome and reference) and submit the dissertation.
- Project report would be evaluated both by external and internal examiners.

Question Paper Pattern (for External Examination)

Theory:

Question	Unit	Marks
Q – 1 Or Q – 1	From Unit I	14
Q – 2 Or Q – 2	From Unit II	14
Q – 3 Or Q – 3	From Unit III	14
Q – 4 Or Q – 4	From Unit IV	14
Q – 5*	From Unit I to IV	14

*Objective type questions like Multiple choice / match A & B / fill in the blank / True or false / give one word / expand abbreviations etc.

Practical:

Q – 1. Major experiment	20 Marks.
Q – 2. Minor experiment	14 Marks.
Q – 3. General experiment	10 Marks.
Q – 4. Comment	16 Marks.
Q – 5. Viva – voce and journal	10 Marks.

(Pattern may change slightly depending upon the practical topics.)

			Semester - III				
Course		Name of Course	No. Of Hours per Week				
No.	Type		Lectur es	Othe rs	Practic al	Tot al	Cred it
BOT 501	CORE	PLANT ANATOMY, EMBRYOLOGY AND HISTOCHEMICAL TECHNIQUES	3	1	-	4	4
BOT 502	CORE	CLASSICAL AND MOLECULAR GENETICS	3	1	-	4	4
BOT 503	CORE	PLANT BIOTECHNOLOGY	3	1	-	4	4
BOT 504	CORE	BIOPHYSICS, BIOSTATISTICS AND BIOINFORMATICS	3	1	-	4	4
BOT 505	CORE	PRACTICAL – 5 Based on BOT 501 and BOT 502	-	1	3	4	4
BOT 506	CORE	PRACTICAL – 6 Based on BOT 503 and BOT 504	-	1	3	4	4
		TOTAL	12	06	06	24	24
			Semester - IV				
Course		Name of Course	No. Of Hours per Week				
No.	Type		Lectur es	Othe rs	Practic al	Tot al	Cred it
BOT 507	ELECTI VE	PROJECT / STRATEGIC PLANNING (BOTANICAL APPLICATION)	2	2	16	20	20
		ASSIGNMENT (DOCUMENTATION)	1	1	-	2	2
		REVIEW WRITING (RECENT DEVELOPMENT)	1	1	-	2	2
		TOTAL	04	04	16	24	24

M.Sc Semester- I

BOT 401: MICROBIOLOGY, MYCOLOGY AND PHYCOLOGY

Unit – 1. Microbiology

- Classification of micro-organisms, General account of Bacteria, virus and Phytoplasma,
- Microbial culture, growth, yield, response to stress, Microbial ecology, endophytic microbes
- Postharvest spoilage of plant products and its control, value addition of food products using microbes-Probiotic foods, biofilms-Technology and applications.
- Plant diseases due to microbes and their control, Environmental Microbiology.
- Research Institutes for Microbiology in Gujarat and India, Research Journals for Microbiology.

Unit – 2. Mycology

- General characteristics, ultrastructure, hyphal Growth, aggregations in Fungi, Nutrition and Reproduction. Classification by Alexopoulos and Mims.
- General Account of Myxomycetes, Oomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes, Heterothallism, Heterokaryosis and Parasexuality, Mycorrhizae, AM fungi.
- Disease, Classification, Symptoms and Disease triangle. Disease Cycle, Host Parasite relationship, Disease Control, Role of Weather and Soil fertility on disease development.
- Economic significance and important plant diseases, Pathogenicity and Virulence,
- Research Institutes for Mycology in Gujarat and India, Research Journals for Mycology.

Unit - 3. Phycology

- Criteria for Classification of algae: pigments, reserve food, flagella. Classification – Smith and Van Hock . Thallus organization and Reproduction.
- Characteristics and Cell ultra-structure of Cyanophyta, Chlorophyta, Phaeophyta and Rhodophyta, Origin and Evolution of algae
- Algae in diversified habitats -terrestrial, freshwater and marine, Distribution in India and Gujarat.
- Economic significance, Biofertilizers, Biofuel, Phytoremediation using algae
- Research Institutes for Algae in Gujarat and India, Research Journals for Algae.

Unit - 4 Microbial Techniques

- Methods in the study of microbiology, mycology and phycology, Culturing Bacteria, Culturing algae, culturing Fungi, factors affecting growth, calculating biomass and preservation techniques

- Value addition using microbes-utilization of lignocelluloses, Consolidated Bioprocessing (CBP), Biotechnological applications- alcohol, biodiesel, Cells as biofactories, Sugars from agricultural residues, Bioplastics, etc.
- Solid waste management using fungi, Mushroom Cultivation, Large scale commercial utilization of fungi in Gujarat
- Extraction of biologically active compounds from algae by microwave assisted extraction (MAE), Large scale commercial utilization of algae in Gujarat.
- Research Institutes using Microbial Techniques in Gujarat and India on a large scale, Research Journals for Microbial techniques.

BOT- 402: CRYPTOGAMS, GYMNOSPERMS AND EVOLUTION

Unit – 1. Bryophytes

- General Account, Alternation of generation. General Classification by Rothmaler and Proskauer, characteristics of Marchantiales, Jungermaniales, Anthocerotales, Sphagnales, Funariales and Polytrichales.
- Origin and evolution, Habitat, Reproduction-Vegetative, Sexual, parasitic bryophytes, carnivorous liverworts,
- Economic, Ecological and evolutionary significance, biomapping and biomonitoring using bryophytes
- Distribution in India and Gujarat, Collection, Documentation and Preservation methods.
- Research Institutes for Bryophytes in Gujarat and India, Research Journals for Bryophytes.

Unit - 2. Pteridophytes

- General characters. Origin and evolution, Alternation of generation, Evolution of Stele, Telome theory.
- Classification – Smith (1955) and General characters of Psilophyta, Lycophyta, Sphenophyta and Pterophyta. Spore producing parts and Soral Evolution. Origin and development of Heterospory. Origin of Seed habit.
- Fossil Pteridophytes, evolutionary, ecological and economic importance
- Distribution in India and Gujarat, Collection, Documentation and Preservation methods
- Research Institutes for Pteridophytes in Gujarat and India, Research Journals for Pteridophytes.

Unit – 3. Gymnosperms

- General characters, Classification by Coulter and Chamberlain, Spore.
- Origin and evolutionary trend – primary vasculature, secondary wood, leaf, male gametophyte, female gametophyte and embryo.
- Distribution of Gymnosperms in time and space (India). Economic Importance of Gymnosperms

- Paleobotanical study- techniques, Paleoclimates, process of fossilization. Types of fossils, Pteridospermales, Pentoxylales and Cordaitales.
- Research Institutes for Gymnosperms in Gujarat and India, Research Journals for Gymnosperms.

Unit – 4. Evolution

- Evolution of life cycles, plant anatomy, plant morphology, leaf, roots, tree forms, seeds, flower, inflorescence
- Evidences and theories of organic evolution, Natural selection, Darwin – Lamarck theory, Sources of Variation
- Evolution of photosynthetic pathways, evolution of transcriptional regulation, evolution of secondary metabolism
- Evolutionary divergence, isolating mechanisms, adaptation, Molecular evolution- molecular divergence, molecular clocks, molecular tools in phylogeny, coevolution of plants and fungal parasites
- Convergent evolution, Divergent evolution, Co-evolution, reverse evolution, Microevolution, Macroevolution.

BOT 403 : PLANT TAXONOMY

Unit – 1. Botanical Nomenclature

- Vegetative and reproductive plant parts and their modifications
- Taxonomy and systematic botany, aim, concepts of plant classification.
- Botanical nomenclature, International Code of Botanical Nomenclature, Author citation, International association for plant taxonomy (IAPT), International code of Nomenclature for cultivated plants (ICNCP), International Plant names Index (IPNI), International code of nomenclature for algae, fungi and plants (ICNafp), hybrid names.
- Tools of taxonomy, plant explorations, collection, methodology, BSI,
- Research Institutes for Taxonomy in Gujarat and India, Research Journals for Taxonomy.

Unit – 2. Classification Systems

- Taxonomic hierarchy, Plant identification, construction and use of keys, taxonomic literature- flora of Gujarat, manuals etc
- Phytogeography, regions of the world, Plant families – dicot (15) and monocot (05) characteristics with representative examples and economic importance
- Systems of classification (Natural, artificial, phylogenetic) and their merits/ demerits.
- Angiosperm Phylogeny Group system (APG), APG II, APG III, APG IV
- Phytogeography of Gujarat, Forests in Gujarat

Unit – 3. Biosystematics and applied Taxonomy

- Taxonomic evidences-morphology, anatomy, embryology,
- Numerical Taxonomy-Cladistics, Dendrograms and Cladogram construction.
- Chemotaxonomy-Alkaloids, glycosides, Phenolic substances, essential oils, fats and oils.
- Botanical gardens in Gujarat and India, National –International societies in biosystematics
- Selected Case studies to illustrate the use of taxonomic evidences in clarifying classification

Unit – 4. Botanical Techniques

- Morphological: peel mounts, whole mounts, stomata, trichomes etc and anatomical techniques: TS, LS, TLS, RLS etc to identify plants.
- Herbarium techniques for algae, fungi, bryophytes, pteridophytes, Gymnosperms and Angiosperms
- Other documentation methods: e-herbarium, digital databases etc
- Videographic and photographic techniques for plant identification
- Online identification websites and their application.

BOT-404 : PHYTORESOURCES,ETHNOBOTANY, PHYTOCHEMISTRY and FORESTRY

Unit - 1. Phytoresources

- Origins of agriculture, World centers of primary diversity of domesticated Plants;
- Origin, evolution, botany, cultivation and uses of plants as food, forage-fodder, fuel, fiber, furnishings, flavours, medicinal plants, and oil-yielding plants of Gujarat and India.
- Economic significance of phytoresources, packaging ,cost-benefit ratio of production using specific case studies,profit,alternative uses, crop residue utilization.
- Supply chain management, role of NAFED, APMC, NABARD and other funding agencies, good manufacturing practices, Food technology
- Phytoresources in Gujarat and their sustainable utilization

Unit – 2. Ethnobotany

- Basic methods and approaches to study traditional knowledge, various sub disciplines, NIF, TK to drugs.
- Documentation of ethnobotanical research-questionnaire making and statistical analysis of data, Traditional plant use and management for sustainable development.
- Scope, voucher specimen, verification, screening and potential applications
- Conservation, principles, strategies, *in situ* – *ex situ*, protected areas, gene – seed banks, initiatives (international/ national), IUCN.
- Ethnobotanical research in Gujarat and research journals in Ethnobotany.

Unit – 3. Phytochemistry

- Secondary metabolites, types – characteristics, extraction strategies, analysis, biosynthetic pathways and inter relationships
- Pharmacognosy, morphology (macro – micro), methods, adulterants, quality control.
- Role of phytochemicals, commercial exploitations (cultivation, *in vitro* approaches), important medicinal plants with uses and yielding active principles from underground parts/ whole plant/ flowers/ fruits/ seeds.
- Methods in phytochemical analysis, Instruments and equipments in a phytochemistry laboratory, Pharmacy and other related research institutes in Gujarat and their mandate.
- Research using plant based proteins and their value addition.

Unit - 4. Forestry

- Non-wood forest products (NWFPs): Raw materials for paper – making, Gums and Resins, Dyes, medicines, and forest products like wood, alkaloids etc
- *In situ* conservation-constraints and challenges. *Ex situ* conservation- constraints and challenges with case studies,
- Participatory forest management, social forestry, carbon sequestration by forests
- Biosphere reserves, sanctuaries and National Parks in Gujarat and India, mandate and status
- Forests research Institutes in India, Research Journals of Forestry.
- Deforestation, Afforestation, Miyawaki forests and Agroforestry.

BOT 405PR: Practical – I: Based on topics covered in BOT 401 and 402

BOT 406PR: Practical – II: Based on topics covered in BOT 403 and 404

Semester II

BOT 407: CYTOLOGY AND MOLECULAR BIOLOGY

Unit – 1. Cytology

- Plasma Membrane: Structure, Models and Functions, sites for ATPases, ion carriers, Channels and pumps, receptors; Plasmodesmata: Structure and Functions. Plant Vacuole: Tonoplast membrane and functions.
- Structure and function of Nucleus, Microbodies, Golgi apparatus, Lysosomes and Endoplasmic Reticulum.
- The Cytoskeleton; Organization and Role of Microtubules and Microfilaments; Control Mechanisms; Role of Cyclins and Cyclin - dependent Kinases. PCD in Plant life cycle.
- Enzymes, Commercial enzymes-isolation, purification and significance
- Cell mortality, immortality, Researches in Cell Biology.

Unit - 2. Gene Structure

- Structure, Recombinant technology, Applications, Cell signaling and communication, Cancer and cell cycle, RNA splicing, miRNA-functions ,

- Regulation and expression of genes in prokaryotes and eukaryotes
- Organelle genome, evolutionary significance, Gene families, jumping genes and split genes
- Genomics-software, methods and applications , Transcriptome analysis-methods and applications through case studies
- Cell cycle and DNA damage repair system.

Unit - 3 Cytochemical methods and techniques

- Microscopy : Light, Phase contrast, Fluorescence, polarizing and Electron
- Cellular measurements, micrometry, camera lucida application, Cytochemical methods – principle of staining for DNA, RNA, Proteins, Lipids, cytophotometer
- Centrifugation : differential, density gradient and ultracentrifugation
- Staining, Photographic methods,
- Enzyme cytochemistry- methods and applications

Unit 4 Separation methods

- Electrophoresis: Principle, types, IEF, technique and application.
- Chromatography: Principle, types : Size exclusion, ion exchange, affinity, TLC, GLC, HPLC, HPTLC technique and application.
- DNA isolation, purification and quantification, ISH, FISH, GISH, Karyotyping
- Protein isolation, purification and quantification, proteomics and protein structure prediction through homology modelling
- Immunochemical methods - ELISA, Immunoblotting, Immunoelectrophoresis, Immunochromatographic assay.

BOT 408: PLANT ECOLOGY

Unit – 1. Basics of Ecology

- Ecological Factors: Soil, light, water etc, Principles of limiting factors; biotic factors, Productivity
- Population ecology, concept, type, fluctuations, factors regulating size, autecology, mortality, natality.
- Ecosystem Organization: Structure and Function, Types, Energy Flow in Ecosystem, Biogeochemical cycles (C, N, P and S).
- Fragile ecosystems, Integrated coastal zone management-projects, scope and major findings, Preserving ecosystems
- Floodplain ecology, Grassland ecology, restoration ecology,

Unit – 2. Community and Biodiversity

- Vegetation Organization: Composition and Structure of Plant Community, Qualitative and Quantitative Characteristics, Phytosociological Methods, Ecological Niche.
- Vegetation Development: Process of Ecological Succession, Models and Climax Stage, Hydrosere, Xerosere and causes of succession, Vegetation analysis.

- Biological Diversity: Concepts and levels; role of biodiversity in ecosystem functions and stability; speciation and extinction; IUCN categories of threat; biodiversity hot spots; ecology of plant invasion ; Invasive species-case studies
- Mapping biodiversity, methods of estimating population density of plants and documenting biodiversity by PBR, Role of GSBB, NBA
- Biodiversity of Gujarat and India, Cultural Forests in Gujarat, Heritage sites in forests and sacred groves.

Unit – 3. Environmental Issues

- Climate Change: Greenhouse gases (CO₂, CH₄, N₂O, CFCs; sources, trends and role); ozone layer and ozone hole, consequences of climate change (CO₂ fertilization, global warming, sea level rise, UV radiation).
- Environmental Pollution: Air, Land, noise and Water. Pollution, kinds; sources; quality parameters.
- Ecological Adaptations, various adaptations, types, sustainable development, EIA.
- Bioremediation, Phytoremediation, conservation and management strategies / projects : challenges and success stories
- Researches on climate change effects on Biodiversity, Appropriate technology, Alternative technology for climate change.

Unit – 4. Remote Sensing

- Principles, components and types of Remote sensing.
- Data acquisition, processing-use of softwares, landuse and landcover studies with special focus on Gujarat
- Applications of remote sensing in solid waste landfill monitoring, Hydrology, Biodiversity mapping, forestry, agriculture and disaster management
- IRS, RADAR, GIS, GPS and their importance, Bhuvan- advantages
- Thermal remote sensing -methods and applications.

BOT 409: PLANT PHYSIOLOGY

Unit – 1. Water and Mineral Nutrition

- Water, water potential, soil water, water absorption and transport, transpiration, water deficit, hormonal and molecular responses to water control in plants.
- Mineral nutrition, macronutrients, micronutrients, importance and deficiency symptoms, nutrient uptake by plants
- N–P–K in environment, Nitrogen-Phosphorus-Potassium metabolism, N-P-K assimilation, BNF
- Carbohydrates, Proteins, Lipids-biosynthesis , Structure and metabolism
- Plant symbiotic interactions, Journals and research trends in Mineral Nutrition in Plants.

Unit – 2. Major Pathways

- Photosynthesis, photosynthetic apparatus, PS I & PS II, mechanism of electron – proton transport, carbon fixation (C₃/ C₄/ CAM), evolution of Photosynthesis, factors affecting photosynthesis, photorespiration – C oxidation cycle,
- Respiration, Mitochondria, structure, glycolysis, TCA cycle, electron transport, ATP synthesis, different substrates, carbon respiration
- Measurement of Photosynthesis, Respiration and Transpiration
- Translocation of photosynthetic phloem, source – sink, partitioning and allocation
- Research trends in Photosynthesis and Respiration, Journals in Plant Physiology

Unit – 3. Growth and Development

- Growth, development, concept, qualitative – quantitative changes, Seed germination, dormancy and method to break dormancy.
- Growth regulators, biosynthesis, bioassay, mechanism of action, physiological effects, applications of auxin, cytokinin, gibberellins, ABA, ethylene.
- Physiological effects and role of jasmonic acid, polyamines, brassinosteroids, salicylic acid, ROS and Nitric oxide signaling in plants.
- Measurement of growth, growth indices-RGR, LWR and NAR, growth correlations.
- Research trends in Plant hormones, Infra red spectroscopy methods and application in phytohormone determination.

Unit – 4. Plant Responses

- Phytochrome, Pr and Pfr structure, localization, plant responses, plant movement, cellular actions
- Flowering, shoot apex modification, floral meristem, photomorphogenesis, photoperiodism, biochemical signaling, vernalization
- Stress physiology, water status, deficit, drought, structural and biochemical features to overcome stress, chilling, Heat and salinity stress.
- Climate resilience, vulnerability and Tolerance to stress
- Research trends in Plant abiotic and biotic stress, Biotechnological approaches

BOT - 410: PLANT BREEDING, AND HORTICULTURE

Unit - 1. Breeding

- Plant breeding – objectives, origin, domestication, hybrid vigour
- Principles and methods of Plant Breeding, Self pollinated crops, Cross pollinated crops, Clonal crops
- Plant Introductions – NBPGR, Challenges and achievements.
- Marker assisted selection, reverse breeding, participatory plant breeding, Institutes and key plant breeders
- Researches on assessment of genetic variability and genetic diversity in plants.

Unit – 2. Horticulture

- Propagation by seeds and vegetative structures, harvesting, storage and viability, germination, dormancy (seed and bud), Pretreatments
- Techniques, anatomical and Physiological aspects of rooting of cuttings, Types of cuttings, Grafting, Budding, Layering
- Important horticultural crops of India with emphasis on Gujarat fruit/ flowers, cultivation, harvest and post – harvest handling.
- Hi tech Horticulture-Propagation, postharvest storage, protection
- Research trends in Horticulture.

Unit – 3. Gardening and Landscape

- Cultivation under cover, greenhouse: advantages, construction, types, maintenance. Organic farming, mulching, composting, IPM, advantages
- Landscaping – principles, types, planning, Xeriscaping.
- Garden: features, elements, styles, Indoor gardening, Gardens of India.
- Sustainable utilization of resources, funding agencies, Corporate social responsibility and other initiatives-case studies, Role of ICAR, NBPGR, CPCRI, CTCRI, APEDA, NABARD etc
- Non plant elements in landscaping- use and care.

Unit – 4. Sustainable utilization for challenges of climate change

- Energy efficient growing techniques, water use efficiency, solar energy utilization
- Biogas –Technology and scope, green buildings –concept and future,
- Zero waste and low carbon landscape-methods and constraints, carbon credits-concept merits
- Food technology for better health
- Regenerative Landscape, Environmental landscape.

BOT 411PR: Practical – I: Based on topics covered in BOT 407 and 408

BOT 412PR: Practical – II: Based on topics covered in BOT 409 and 410

Semester III

BOT - 501: ANATOMY, EMBRYOLOGY AND HISTOCHEMICAL TECHNIQUES

Unit – 1. Anatomy

- Root anatomy, RAM, root hairs, root architecture,
- Stem anatomy, Vascular elements, functional differentiation, p proteins. Role of cambium.

- Leaf anatomy, Epidermis, stomata, trichomes, types, role, Secretory Ducts and Laticifers, types, development, function. Nodal Anatomy, Nodal types, leaf gaps, branch
- Wood anatomy, Wood development and environmental factors, heartwood, softwood and bark, reaction wood
- Research trends in Anatomy, Research Journals in Anatomy

Unit - 2. Embryology

- Floral meristem, Intrinsic and extrinsic factors controlling flowering, flower development, ABC model of flower development, flower architecture and mutations.
- Structure and development of anther, ovule, male and female gametophytes; Embryo sac ultra-structure and its types, nutrition of embryo sac.
- Pollination, pollen-pistil interaction, fertilization, sexual incompatibility,
- Embryo development, types, polyembryony, endosperm, nutrition.
- Research trends in Embryology, Research Journals in Embryology

Unit - 3. Applied Embryology

- Palynology, morphographic palynology, aeropalynology, melittopalynology, and Paleopalynology.
- Apomixis, types and applications, Modern approaches- pollen allergy, forensic palynology and other applications.
- Sterility –phenomenon and applications in hybrid seed production, male sterility-chemical induction , through recombinant DNA technology
- Pollen biotechnology in agriculture- optimizing yield, effective plant pollinator interactions through case studies.
- Research trends in Palynology, Research Journals in Palynology

Unit - 4. Histochemical techniques

- Whole mounts, sections, peels for study of fine surface and internal structures of plants, stains, mounting for temporary preparations.
- Killing, fixing, sectioning and staining for permanent preparations.
- Unstained preparations and study of live cells, photographing stained preparations, Pollen pistil interactions through temporary preparation.
- Staining for callose, DNA, RNA, Proteins, insoluble polysaccharides.
- Immunohistochemistry and research trends in histochemistry

BOT - 502: CLASSICAL AND MOLECULAR GENETICS

Unit - 1. Mendelian Genetics

- Genetics – principles of inheritance, pea as a model hybrids, extra chromosomal inheritance, chloroplast, mitochondria (genome and genes)
- Gene interactions, linkage and crossing over, genetic mapping

- Extra genome and genes, Chromosome aberrations, ploidy, variation in structure and arrangement, mutagens. physical – chemical, molecular basis, recombination, transposons.
- Gene editing, FTO genes, CRISPR, Genetic surgery
- Research trends in Genetics, Research Journals in Genetics

Unit – 2. Molecular Genetics

- Molecular basis of genetics, experiments, DNA, characteristics, structure, forms of DNA, gene – genome, replication
- Genetic expression, transcription, code, translation, modification, Cloning vectors and strategies,
- Nucleic acid sequencing methodologies
- Recent advances of molecular genetics in cancer, glaucoma, malaria, epilepsy, plant improvement programmes.
- Research trends in Molecular genetics, Research Journals in Molecular genetics

Unit – 3. Genetic Engineering

- Recombinant DNA technology, restriction enzymes, gene cloning, choice of vectors.
- DNA-types, and RNA-types, DNA barcoding-methods, status, significance and challenges, Construction of genomic/ cDNA library, PCR
- DNA analysis, Southern – Northern blotting, sequencing, molecular markers, microarrays, RNA interference, small RNAs, microRNAs, RNAi based modifications
- BIG data- characteristics, architecture, technologies and applications
- Research trends in Genetic Engineering, Research Journals in Genetic Engineering

Unit - 4. Biosafety, Bioethics and Patents

- Biosafety- bioethics, concept, objectives, risk assessment, containment, NIH guidelines and biosafety regulations
- IPR, patent, benefits, GATT, WTO, TRIPS, UPOV,
- Seed certification, release of varieties, Breeder's right, legislations.
- GMO, GM foods, nanomedicines, DBT guidelines for approval of transgenics, Bioethics in biodiversity and resource management.
- Current Trends in Biosafety in Research

BOT – 503: PLANT BIOTECHNOLOGY

Unit - 1. Plant Tissue Culture

- General technique, Laboratory and equipments, aseptic techniques, nutrient medium, plant growth regulators
- Callus, induction, transfer – subcultures, growth kinetics, cell suspension, application

- Morphogenesis, Plant regeneration, somatic embryogenesis, advantages, synthetic seeds, androgenesis and gynogenesis
- Micropropagation, cloning, various stages, applications, pathogen indexing, meristem culture, virus free plants, therapy (chemo/ thermo), advantages
- Research trends in Plant Tissue culture, Research Journals in Plant Tissue Culture

Unit – 2. Plant Improvement

- Somatic hybridization, protoplast isolation, culture, fusion, selection of hybrids, advantages.
- Somaclonal variation, origin, factors inducing variations, cell selection, advantages
- Transgenic plant, gene construct, Ti plasmid, transformation, direct gene transfer methods, advantages
- Phytochemicals, large scale cultures, bioreactors, improvement – elicitors, two phase systems, hairy root cultures, bio-transformation, applications
- Research trends in Plant Improvement, Research Journals in Plant Improvement

Unit – 3. Industrial Applications

- Studies on Primary metabolites
- Studies on secondary metabolites
- Studies on fine chemicals produced by plants like Shikonine, berberine, geraniol, digoxin, rosmarinic acid and immunologically active polysaccharides from plants
- Studies on Plant made Pharmaceuticals (PMP) for human use
- Research trends in anti inflammatory and cytotoxic phytochemicals

Unit – 4. Complementary Techniques

- Germplasm conservation, cryopreservation (freezing – thawing), cryoprotectants, applications
- Distant hybridization, *in vitro* pollination/ fertilization, embryo culture, embryo – rescue, applications.
- Commercial outlook, technology, important plants, International and Indian status, issues. Plant tissue culture in India
- Molecular markers and DNA finger printing techniques and applications
- New Plant Breeding techniques (NBT)- Site directed nucleases, Oligonucleotide Directed Mutagenesis, Cisgenesis, RNA-dependent DNA methylation, Grafting between Non-GM scion on GM rootstock, Reverse breeding and Agro-infiltration

BOT - 504: BIOPHYSICS, BIOSTATISTICS AND BIOINFORMATICS

Unit - 1. Biophysics

- Molecular mechanics: Free radicals, bonds: types and their role.
- Laws of thermodynamics, role in plant processes and functions.

- Tracer techniques, autoradiography: principle and working, effect of radiation on biological system.
- X-ray crystallography, AAS, Atomic Force Microscopy, NMR, MALDI-TOF
- Magnetic tweezers and Optical tweezers-Principles and applications

Unit – 2. Biostatistics – Scope and Methods

- Principle and scope of statistical methods in biological research, sampling, data - types, data collection, presentation of data, and measures of central tendency - mean, median, mode. Standard deviation/ error, coefficient of variation
- Probability - definition, various events in probability, laws, linear correlation, linear regression
- Hypothesis testing, tests of statistical significance (chi square, student t test) ANOVA, use of computer in statistical analysis, SPSS, confidence limits,
- Quality assurance and quality control, errors - types of errors, Data analysis
- Role of Biostatistics in research, Softwares for data analysis in Biostatistics

Unit – 3. Basics of Computers

- Introduction to Bioinformatics and basics of computers and internet.
- Operating systems, computer networks
- MS office and essentials: MS word, MS Excel, MS powerpoint, MS Picture Manager
- Databases-introduction to various biological databases, Primary, Secondary and specialized databases
- Latest technology in computers-Block Chain, Virtual reality, artificial Intelligence, Voice technology

Unit - 4. Bioinformatics Tools

- Biological information retrieval, sequence formats (GenBank, PDB, SWISS-Prot etc.), submitting sequences to databases, Pattern searching
- Sequence alignment., Sequence analysis: Collecting and storing sequences, Gene Prediction, Multiple sequence alignment
- Genomics and proteomics, applications, Comparative genomics and phylogenetic studies
- Protein modelling: Protein structure prediction, Homology modeling and threading, Docking and Principles: Protein-Protein/ligand docking, Protein and small ligand docking.
- Research trends and applications of Bioinformatics tools.

BOT 505PR: Practical – I: Based on topics covered in BOT 501 and 502

BOT 506PR: Practical – II: Based on topics covered in BOT 503 and 504

Semester IV

BOT 507 Project / Strategic Planning (Botanical Application)

Assignment (Documentation)

Review article (Recent writing)

SUGGESTED READINGS:

1. Cooper, T.G. 1977. *Tools in Biochemistry*. John Wiley, New York. USA.
2. Copeland, R.A. 1996. *Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis*. VCH Publishers, New York.
3. Dennison, C. 1999. *A Guide to Protein Isolation*. Kluwer Academic Publishers. Dordrecht, the Netherland.
4. Dryer, R.L. and Lata, G.F. 1989. *Experimental Biochemistry*. Oxford University Press, New York.
5. Harborne, T.C. 1981. *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis*. Chapman and Hall, London.
6. Plummer, D.T. 1988. *An Introduction to Practical Biochemistry*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
7. Economic Botany – by S. L. Kochhar
8. Economic Botany – by A. V. S. S. Samba Murty and N. S. Subrahmanyam.
9. Economic Botany – by Bendre & Kumar
10. Ethno botany – Rajiv K. Sinha & Shweta Sinha
11. Contribution to Indian Ethno botany – I
12. Contribution to Indian Ethno botany – I – Jain. S. K
13. Ethno botany, Interdisciplinary Science Reviews
14. Economic Botany by A.V.S.S. Samba Murty and N.S. Subramanyam, Wiley Eastern Ltd.
15. A Manual of Ethnobotany, 2nd Edition, by S.K. Jain. Scientific Publishers, Jodhpur.
16. Ethnobiology, by Rajiv K. Sinha and Shweta Sinha, Surbhi Publication, Jaipur.
17. Wilson, K. and Walker, J. 1994. *Practical Biochemistry: Principles and Techniques*, (4th Ed.). Cambridge University Press, Cambridge, U.K.
18. Bhojwani, S.S. 1990. *Plant Tissue Culture: Theory and Practical* (a revised edition). Elsevier Science Publishers, New York, USA.
19. Bhojwani, S.S. 1996. *Plant Tissue Culture: Application and Limitations*. Elsevier Science Publishers, New York, USA.
20. Vasil, I.K. and Thorpe, T.A. 1994. *Plant Cell and Tissue Culture*. Kluwer Academic Publishers, the Netherlands.
21. Shantharam, S. and Montgomery, J.F. 1999. *Biotechnology, Biosafety and Biodiversity*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
22. Glick, B.R. and Thomson, J. E. 1993. *Methods in Plant Molecular Biology and Biotechnology*. CRC Press, Boca Raton, Florida.
23. A Text Book of Biotechnology, R. C. Dubey, S. Chand Publication
24. Bioinformatics-A beginners Guide-Claverie J & Notredame C
25. Developing Bioinformatics Computer Skills-Gibas C & Jambeck P
26. The single Genetic Algorithm-Vose M D
27. Bioinformatics-Sequence, structure and Databases –Higgins D & Taylor W.
28. Basic Biophysics by M. Daeniel, Agrobotanical Publishers
29. Principles and Techniques of Practical Biochemistry by Keith Wilson and John Walker Cambridge University Press.
30. Environmental Science by S. C. Santra, New Central Publication, Kolkata.
31. Electrophoresis Theory, Techniques, and Biochemical and Clinical Applications, by Anthony T. Andrews, Clarendon Press, Oxford.

32. Useful Techniques for Plant Scientists, Arvind M. Dhopte and Manuel Livera, Publication Forum for Plant Physiologist, Akola, India.
33. Agrios, G. N. 1988. *Plant Pathology*. Academic Press.
34. Alexopoulos, C.J., Mims, C.W. and Blackwel, M. 1996. *Introductory Mycology*. John Wiley and Sons Inc.
35. Foster, A.S. and Gifford, E.M. 1967. *Comparative Morphology of Vascular Plants*. Vakils Feffer and Simons Pvt. Ltd. Bombay.
36. Gareth Jones, D. 1989. *Plant Pathology - Principles and Practice*. Aditya Books, New Delhi.
37. Kumar, H.D. 1988. *Introductory Phycology*. Affiliated East - West Press Ltd., New Delhi.
38. Mehrotra, R.S. and Aneja, R.S. 1988. *An Introduction to Mycology*. New Age Intermediate press.
39. Mehrotra, R.S. 1988. *Plant Pathology*. New Age Intermediate press.
40. Rangaswamy, G. and Mahadevan, A. 1999. *Diseases of Crop Plants in India*. (4th Ed.). Prentice Hall of India Pvt. Ltd., New Delhi.
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 64. Taiz, L. and Zeiger, E. 1998. *Plant Physiology* (2nd edition). Sinauer Associates, Inc., Publishers, Massachusetts, USA.
 65. Thomas, B. and Vince-Prue, D. 1997. *Photoperiodism in Plants* (2nd edition). Academic Press, San Diego, USA.
 66. Bewley, J.D. and Black, M. 1994. *Seeds: Physiology of Development and Germination*. Plenum Press, New York.
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 72. *Basic Ecology* – Eugene P. Odum
 73. *Fundamentals of Ecology*- P. Odum
 74. *Concept in Indian Ecology and Environmental Science* – S. V. S. Rana
 75. *Ecology Theories and Application* – Peter Stiling
 76. *Ecology & Environment* – P. D. Sharma
 77. *Indian Manual of Plant Ecology* – R .Misra & G. S. Puri
 78. *Responses of Plants to environmental stresses*, Levitt, J. (1980) Academic Press.
 79. *Ecology*, N.S. Subrahmanyam and A.V.S.S. Sambamurthy, Narosa Publishing House
 80. *Bioinformatics-A beginners Guide*-Claverie J & Notredame C
 81. *Developing Bioinformatics Computer Skills*-Gibas C & Jambeck P
 82. *The single Genetic Algorithm*-Vose M D
 83. *Bioinformatics-Sequence, structure and Databases* –Higgins D & Taylor W.
 84. *A Text Book of Biotechnology*, R. C. Dubey, S. Chand Publication.
 85. *Basic Biophysics* by Deniel, Agrobotanical Publishers
 86. *Principles and Techniques of Practical Biochemistry* by Keith Wilson and John Walker Cambridge University Press.
 87. *Environmental Science* by S. C. Santra, New Central Publication, Kolkata.
 88. *Electrophoresis Theory, Techniques, and Biochemical and Clinical Applications*, by Anthony T. Andrews, Clarendon Press, Oxford.
 89. *Useful Techniques for Plant Scientists*, Arvind M. Dhopte and Manuel Livera, Publication Forum for Plant Physiologist, Akola, India.
 90. *Biostatistics* by W W Daniel , Wiley Eastern Publication.
 91. *Biostatistics* by Rosner, Cengage Publication
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